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TUNGSTEN – MOLYBDENUM ORE FLOTATION TAILINGS FOR CERAMIC TILE PRODUCTION

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The results of using as a fluxing component in ceramic mixes flotation tailings of tungsten – molybdenum ores from the Kaitashskoe mine are presented. Flotation tailings used in ceramic-tile mixes lower the production costs of the finished products, decrease the firing temperature, make it possible to salvage the mining wastes, and yield articles with the required technical properties.

Work on using the tailings from the Kaitashskoe mine as raw material in the production of ceramic tiles has been performed at the Tashkent Scientific – Technical Institute of Chemical Technology. Flotation tailings which are formed as a result of the processing of tungsten – molybdenum ore take up hundreds of hectares of useful land and amount to 1.20×10^7 tons. The yearly average amount of tailings dumped since 1976 is 1.10×10^5 tons.

The chemical composition of the flotation tailings is as follows (%²): 41.70 – 43.10 SiO₂, 8.56 – 9.23 Al₂O₃, 13.42 – 14.50 Fe₂O₃, 18.90 – 19.24 CaO, 3.90 – 4.80 MgO, 0.36 – 0.49 TiO₂, 0.32 – 0.56 Na₂O, 0.14 – 0.28 K₂O, 0.01 – 0.10 SO₃, 8.94 – 10.59 other. This is a finely disperse, sand-like, dark-gray material with plasticity 6.7. Carbonates are present in the tailings; this has been confirmed by mineralogical analysis. The main rock-forming minerals are kaolinite (21.77%), calcite (36.40%), hydromica (3.68%), and hematite (15.80%); the remainder consists of SiO₂ and other impurities.

Differential thermal analysis of the flotation tailings shows that the free and physically bound water evaporates in the temperature range 20 – 250°C and water is also partially released from hydromicas as a result of their degradation. The exothermal effect at 430°C corresponds to the removal of water of crystallization and burnup of organic impurities, and the exothermal effect at 580°C corresponds to the removal of water of crystallization and partial destruction of the crystal lattice of kaolinite. The endothermal effect at 846°C is due to the polymorphic transformations of quartz. The exothermal effect peaking at 980°C is accompanied by

the appearance of new phases of anortite and hematite. Most of the structural water is removed at temperatures 800 – 1000°C.

These flotation tailings are low-melting; their refractoriness is 1130 – 1160°C.

The kaolin – chamotte – Kaitashskoe tungsten – molybdenum ore (KTMO) flotation tailings system was studied to determine the optimal mix and the physical-mechanical properties of the samples. The effect of the grain composition of the neutral additives and the firing temperature regime on the technological properties of the mixes and their sintering temperature was investigated.

The samples were calcined for 5 h in a silit furnace at temperatures 850 – 1050°C with soaking time 1 h at the maximum temperature.

The mixes for the plastic molding were prepared by dry mixing of angren clay powder with neutral additives followed by the addition of water up to the molding moisture content.

The samples were formed from mixes by introducing into the mixes 4 – 5% chamotte from angren clay with maximum grain size 1 and 2 mm. When KTMO flotation tailings are added to the mixes, the molding moisture content of the mix decreases from 16.8 – 18.0 to 14.5 – 16.0% and the shrinkage in air decreases from 7.00 – 9.60 to 2.78 – 4.80%. The sensitivity of the mixes to drying remains practically constant at 0.62 – 0.65.

The bending strength of the dry samples decreases from 1.20 to 0.86 MPa because of the high sand content of the mixes (Table 1).

As the temperature increases further, the samples swell. Taking account of the presence of micas and hematites in the flotation tailings on the basis of the mass-loss change on heating (see Fig. 1), the samples were soaked at constant

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² Here and below — content by weight.

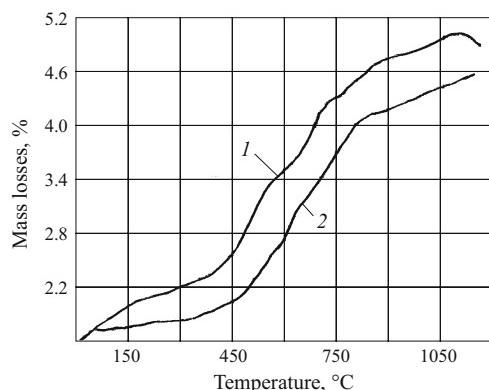


Fig. 1. Variation of the flotation tailings mass losses on heating: 1, 2) flotation tailings in the form of powder and granules, respectively.

temperatures 850 – 1000°C for 2 h, after which they were fired at 1050°C for 2.5 h. However, this did not yield the expected results, since the water absorption of the samples was in the range 6.5 – 8.1% because of the onset of swelling of the mixes (Table 2).

In subsequent investigations, the particle size of the flotation tailings and the tailings content in the mixes were both increased. For the mix 3F, 46% flotation tailings with particle size 0.5 mm were introduced into the mix. Decreasing the granular composition of the flotation tailings to < 0.5 mm makes it possible to decrease the calcination temperature and to obtain, in the interval 950 – 1000°C, articles with water absorption that meets GOST 286–74 requirements. In this case, the firing temperature interval is > 50°C. The density of the samples is 2550 – 2890 kg/m³, the total shrinkage is 4.2 – 6.9%, the compression strength is 50.9 – 65.7 MPa, and the acid-resistance is 96.05 – 98.30%.

The activation energy of the sintering processes in kaolin clay with flotation tailings as determined by differential non-isothermal kinetics [1] decreases by 20 – 21%.

The samples which were coated with a glaze of angren clay from “Kulol” JSC and fired in the plant’s experimental tunnel furnace meet the requirements established for facing and façade tiles.

TABLE 1.

Mix	Bulk density, kg/m ³	Bending strength, MPa	Air-drying shrinkage, %
1F	1590	1.13	3.80
2F	1620	1.15	4.20
3F	1630	1.20	4.80
4F	1580	0.90	3.12
5F	1600	0.86	2.75

TABLE 2.

Mix	Water absorption, %, at calcination temperature, °C				
	850	900	950	1000	1050
1F	19.5	17.3	9.0	5.8	7.5
2F	18.2	16.1	8.2	4.3	8.1
3F	16.4	14.3	7.0	4.1	6.5
4F	18.4	15.8	8.6	4.5	7.9
5F	21.3	17.8	9.6	6.1	7.7

The calculations showed that for up to 46 – 55% flotation tailings content in the ceramic mix the amount of sulfur and carbonate compounds increases by 0.3%. When they are completely converted into exhaust gases during firing, the SO₃ content in the gases does not exceed the admissible level.

It can be concluded on the basis of the results obtained in the present work that facing and façade tiles with good physical – chemical properties can be obtained with significant economic advantage by introducing from 46 to 55% flotation tailings into the ceramic mixes.

REFERENCES

1. V. M. Gropyanov, et al., “Differential method of determining the kinetic parameters of sintering corundum under non-isothermal conditions,” *Zh. Prikl. Khim.*, **53**(2), 2423 (1980).